

Amendment under Article 19(1)

Claims

[Claim 1] (Currently Amended)

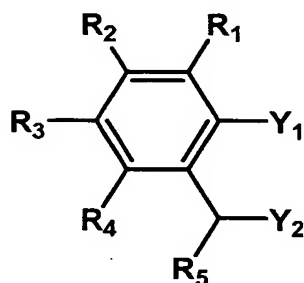
5 A multinuclear rare earth complex formed by coordinating one or more types of molecules having a photosensitizing function and a vibrational energy quenching-suppressing function to a plurality of rare earth ions, which is represented by the general formula:

10 $L_p L'_q (Ln)_r X_s$,

wherein

L is a ligand having a photosensitizing function represented by the general formula:

[Chemical Formula 1]



wherein R₁, R₂, R₃, R₄ and R₅ are independently hydrogen, a hydroxide group, a substituted or unsubstituted amino group, a substituted or unsubstituted aryl group, a nitro group, a cyano group, an alkyl group or a cycloalkyl group represented by -R, an alkoxy group represented by -OR, or an acyl group represented by -C(C=O)R, where R is a substituted or unsubstituted alkyl group or cycloalkyl group having a carbon number of 1 to 20;

20

25

Y_1 is -OH; and

Y_2 is =O;

p is an integer of 1 to 40;

L' is a ligand which is a hydroxide ion;

5 q is an integer of 0 to 8;

Ln is a rare earth ion;

r is an integer of 2 to 20, where a plurality of Ln may be different from each other;

X is O, -OH, S, -SH, Se or Te;

10 s is an integer of 1 to 20, where a plurality of X may be different from each other when s is an integer of 2 to 20; and further, the integers p, r and s have a relationship indicated by the expression:

[Expression 1]

15

$$1 \leq p/r \leq 4, 1 \leq r/s \leq 4$$

wherein a coordination manner of L to Ln is: Coordination Manner (A) where both Y_1 and Y_2 bind to the identical Ln ;

20 Coordination Manner (B) where Y_1 and Y_2 bind to different Ln each other; and a combination thereof, wherein when Y_1 coordinates to Ln , a proton leaves from -OH represented by Y_1 to form -O-, thereby L coordinates to Ln via -O-.

[Claim 2] (Cancelled)

25 [Claim 3] (Cancelled)

[Claim 4] (Currently Amended)

The multinuclear rare earth complex according to claim 1, wherein at least one of substituents R1, R2, R3, R4 and R5 are an alkyl group or a cycloalkyl group

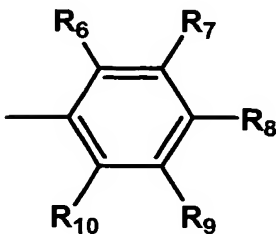
30 represented by -R, an alkoxy group represented by -OR or

an acyl group represented by $-C(=O)R$, where R is substituted or unsubstituted alkyl group or cycloalkyl group having a carbon number of 1 to 20.

[Claim 5]

5 The multinuclear rare earth complex according to claim 4, wherein R_5 is represented by the formula:

[Chemical Formula 2]



10

wherein R_6 , R_7 , R_8 , R_9 and R_{10} are independently hydrogen, a hydroxide group, a substituted or unsubstituted amino group, a substituted or unsubstituted aryl group, a nitro group, a cyano group, an alkyl group or a cycloalkyl group represented by $-R$, an alkoxy group represented by $-OR$, or an acyl group represented by $-C(=O)R$, where R is a substituted or unsubstituted alkyl group or cycloalkyl group having a carbon number of 1 to 20, where at least one of R_1 , R_2 , R_3 , R_4 , R_6 , R_7 , R_8 , R_9 and R_{10} are an alkyl group or a cycloalkyl group represented by $-R$, an alkoxy group represented by $-OR$, or an acyl group represented by $-C(=O)R$, where R is a substituted or unsubstituted alkyl group or cycloalkyl group having a carbon number of 1 to 20.

25 [Claim 6]

The multinuclear rare earth complex according to claim 4, wherein R_5 is an alkyl group or a cycloalkyl

group represented by -R, an alkoxy group represented by -OR, or an acyl group represented by -C(C=O)R, where R is a substituted or unsubstituted alkyl group or cycloalkyl group having a carbon number of 1 to 20.

5 [Claim 7]

The multinuclear rare earth complex according to claim 5 or 6, wherein R is a substituted or unsubstituted alkyl group having a carbon number of 6 to 12.

10 [Claim 8]

The multinuclear rare earth complex according to claim 7, wherein R is a substituted or unsubstituted alkyl group having a carbon number of 8 to 12.

[Claim 9]

15 The multinuclear rare earth complex according to claim 1, wherein the rare earth ion is an ion of lanthanide selected from a group consisting of europium (Eu), terbium (Tb), neodymium (Nd), samarium (Sm), erbium (Er) and ytterbium (Yb) or a combination thereof.

20 [Claim 10]

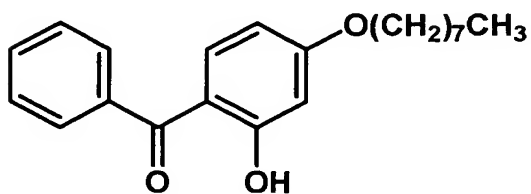
The multinuclear rare earth complex according to claim 5, which is represented by the general formula:

$L_{10}(Ln)_4X$,

wherein

25 L is a ligand represented by the formula:

[Chemical Formula 3]



;

Ln is europium (Eu) ion; and

X is o, and which has the following properties:

Elementary Analysis: as $C_{210}H_{250}O_{31}Eu_4$,

Theoretical values C, 65.04%; H, 6.50%; Eu, 15.67%

5 Observed values C, 64.90%; H, 6.39%; Eu, 15.41%

IR (KBr, cm^{-1}): (ν_{CH})2922, ($\nu_{C=C}$)1596, (ν_{Ph-O})1243

1H -NMR($CDCl_3$): δ 12.7(1H,s), δ 7.6-7.2(3H,m), δ 6.5-6.4(5H,d),
 δ 4.0(2H,t), δ 1.8(2H,m), δ 0.9(3H,t)

FAB-MS: m/z 3552.1 [$Eu_4(L^-)_9O^{2-}$] $^+$.

10 [Claim 11]

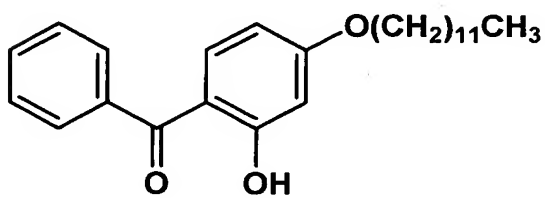
The multinuclear rare earth complex according to claim 5, which is represented by the general formula:

$L_{10}(Ln)_4X$,

wherein

15 L is a ligand represented by the formula:

[Chemical Formula 4]



Ln is europium (Eu) ion; and

X is o, and which has the following properties:

20 Elementary Analysis: as $C_{250}H_{330}O_{31}Eu_4$,

Theoretical values C, 67.64%; H, 7.49%; Eu, 13.69%

Observed values C, 67.50%; H, 7.45%; Eu, 13.49%

IR (KBr, cm^{-1}): (ν_{CH})2924, ($\nu_{C=C}$)1608, (ν_{Ph-O})1247

1H -NMR($CDCl_3$): δ 12.7(1H,s), δ 7.6-7.3(3H,m), δ 6.5-6.4(5H,d),
 25 δ 4.0(2H,t), δ 1.8(2H,m), δ 0.9(3H,t)

FAB-MS: m/z 4055.9 $[\text{Eu}_4(\text{L}^-)_9\text{O}^{2-}]^+$.

[Claim 12]

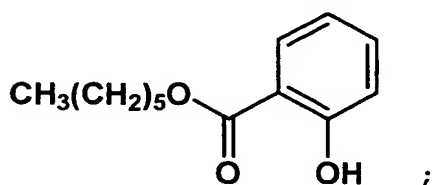
The multinuclear rare earth complex according to claim 6, which is represented by the general formula:

5 $\text{L}_{16} \text{L}'_8 (\text{Ln})_9 \text{X}_2$,

wherein

L is a ligand represented by the formula:

[Chemical Formula 5]



10 L' is OH^- ;

Ln is terbium (Tb) ion; and

X is O, and which has the following properties:

Elementary Analysis: as $\text{C}_{214}\text{H}_{324}\text{O}_{72}\text{NTb}_9$,

Theoretical values C, 46.79%; H, 5.93%; Tb, 26.46%

15 Observed values C, 46.72%; H, 5.18%; Tb, 26.04%

IR (KBr, cm^{-1}): (ν_{CH}) 2957, 2931, ($\nu_{\text{C=O}}$) 1674, 1637,

($\nu_{\text{C=C}}$) 1598, ($\nu_{\text{Ph-O}}$) 1243

$^1\text{H-NMR}$ (CDCl_3): δ 10.9 (1H), δ 7.9-6.9 (4H), δ 4.3 (2H),

δ 1.8 (2H), δ 1.4 (6H), δ 0.9 (3H)

20 FAB-MS: m/z 5140.2 $[\text{Tb}_9(\text{L}^-)_{16}(\text{O}^{2-})_2(\text{OH}^-)_8+2\text{H}^+]^+$.

[Claim 13] (Currently Amended)

A fluorescent substance containing the multinuclear rare earth complex according to any one of claims 1, and 4 to 12.

25 [Claim 14]

A resin formed materials made by compounding the fluorescent substance according to claim 13.